Then, of Course, There is... The Weather

The Catalina Eddy

PART III . . . by Emil Kurtz

THE CATALINA EDDY

Northwest winds 20 to 30 knots over outer channel waters today through tomorrow but near the coast southeast winds 5 to 10 knots night and morning hours becoming southwest 10 to 18 knots in afternoons. Coastal low clouds night and mornings becoming sunny in afternoon.

This forecast seems so full of contradictions that you might be convinced the forecaster has slipped his cable. Most likely he is describing a wind and weather pattern that has acquired the rather interesting and descriptive name "Catalina Eddy." Perhaps if we all knew what this Catalina Eddy is, and what the wind flow pattern is like that goes along with it, the forecast could simply state . . . *"Strong Catalina Eddy today through tomorrow" . . . or "Medium Catalina Eddy" . . . etc.*

In any case let's see what is involved here. First of all, remember that the most persistent pressure feature off the California coast is the Pacific High. The pressure gradient between this high and the characteristically lower pressure over the far southwestern United States maintains the northwesterly current of air over the California coastal waters, most persistent during the summer season. This northwest wind sweeps along more or less parallel to the California coast, pushing inland through broad openings in the Coast Range.

Notice that the coast makes a sharp bend around Point Arguello toward the east, and the coastline of Southern California takes off at a sharply different direction from that north of Point Arguello.

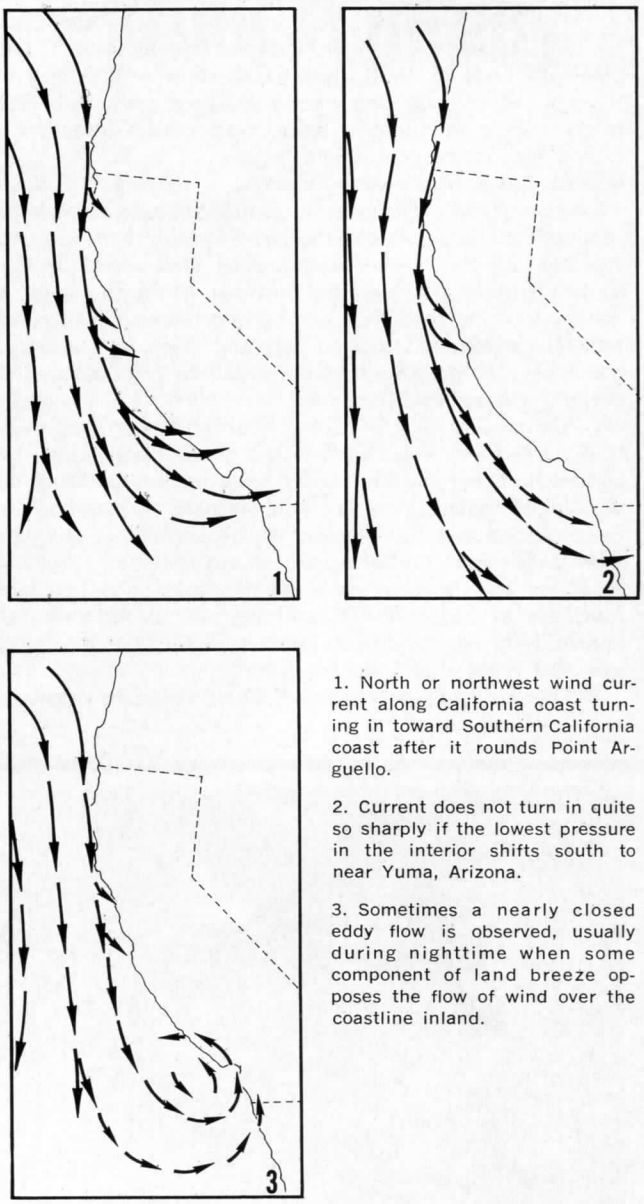
Air moving rapidly can't turn sharp corners, so when a 25 to 30-knot wind moves along the California coast and reaches Point Arguello, it shoots on down to San Nicolas Island unable to make so sharp a turn as the coastline does. However, some of this fast current does turn in toward the coast, and this turning increases as the current proceeds farther south of Point Arguello. Now this swirl of air spinning off the main Northwest current in toward the coastline is our eddy. The sketches illustrate this eddy over the Southern California coastal waters.

Variations of this eddy pattern are created by some of the following influences:

1. *Strength of the pressure gradient between the Pacific High and the Southwest United States low pressure area.*
A stronger pressure gradient increases the Northwest current off Point Arguello, and also the jet that projects on toward the outer islands, such as San Nicolas and San Clemente.

2. *Location of lowest pressure in the Interior Desert.*
If the lowest pressure is, say, around Las Vegas, the forces are stronger to turn this jet current in toward the coast (fig. 1). If the lowest pressure is farther south, say around Yuma, the jet current does not turn in quite so sharply toward the coast (fig. 2).

3. *Land-Sea Breeze influence.*
Nighttime cooling over the land reduces the tendency to draw air in across the coastline and the current of wind turning in toward the coast, meeting the opposition of the land or drainage breeze, is allowed or forced to drift northward along the coast making up a southerly or even a southeasterly wind flow (fig. 3). The sketch shows this effect which often completes a roughly circular flow that dramatically illustrates the Catalina Eddy. Daytime warming over the land increases the sea breeze over the shoreline, and begins to turn this southeast wind around so it comes in from a more southwesterly direction over the coastline.

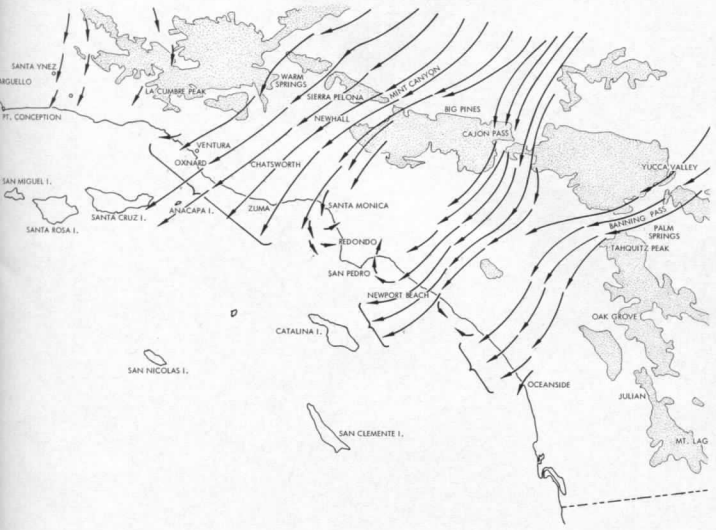


1. North or northwest wind current along California coast turning in toward Southern California coast after it rounds Point Arguello.

2. Current does not turn in quite so sharply if the lowest pressure in the interior shifts south to near Yuma, Arizona.

3. Sometimes a nearly closed eddy flow is observed, usually during nighttime when some component of land breeze opposes the flow of wind over the coastline inland.

and the Santa Ana Wind



Some favorite paths of Santa Ana Winds from the deserts down to the shoreline. Strong Santa Anas can extend out to the Channel Islands. Length of wind arrow is roughly proportional to speed.

Keep in mind this diurnal factor at work to modify the Catalina Eddy.

4. *Location of Center of the Eddy.*

When the Pacific High is strong and its eastern perimeter is close to the Northern California coast, the northwest jet reaches its maximum off Point Arguello, and thrusts on to San Nicolas Island. Then the Eddy centers approximately around Catalina, whence cometh its name.

When the Pacific High drifts farther away from the coast, or pressure begins to fall along the Northern California Coast, a broader eddy may be evident over the coastal waters off Southern California, but its center would then shift away from the coast, perhaps even out west of San Nicolas Island. As a rule, when San Nicolas' wind drops below 10 knots from the northwest, or blows from another direction, we can consider that the Catalina Eddy is not present.

During the Catalina Eddy, the marine layer along the coast is usually so deep that coastal clouds rather than low fog will overlie the coastal waters and coastline.

This Catalina Eddy pattern has been studied by meteorologists for quite some time and in some instances presented as a "cause" of certain behavoir characteristics of other features, such as changes in extent of fog or coastal stratus clouds. It might be better to regard it simply as a condition that can be observed in various stages of development along with changes in patterns of fog or low clouds, and to consider that changes in the eddy and other features of the marine layer are caused by some more complicated broad scale circulation changes beyond your range of view. If, however, it should seem important to set up a cause and effect association we might for convenience think of a strengthening of the eddy as causing a *deepening* of the marine layer with a higher inversion.

THE SANTA ANA WIND

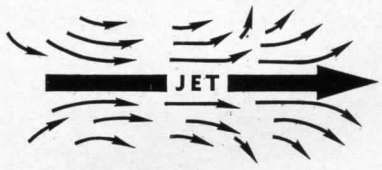
The Santa Ana Wind is a distinctive weather type that works in almost the opposite way as it lowers the inversion and makes the marine layer more shallow.

Let's consider a situation that you may encounter some day if you haven't already. You decide to go boating on a beautiful morning, but when you arrive at the marina you see the Smallcraft Warning pennant draped limply around its staff. Being a prudent skipper knowing that the Warning Flag is a way of requesting that you check the weather forecast, you tune in to FM 162.55 mc on your handy pocket-size radio receiver and hear something like this . . .

Localized North or Northeast winds 15 to 30 knots in areas near coastal canyons late today, tonight and tomorrow, but elsewhere variable winds 5 to 10 knots becoming westerly 8 to 16 knots tomorrow afternoon. Mostly clear.

Would you recognize this as a "Santa Ana Wind" situation? From the reference to winds of 15 to 30 knots blowing from a northeast quarter you should identify it with the Santa Ana weather type. The *mostly clear* should tend to confirm the identification. The word *localized* should tell you that not all points along the coast will feel the dry northeaster but primarily only those exposed to the jets of wind that sweep down the coastal passes to fan out across the shoreline below them.

What about the *but elsewhere variable winds 5 to 10 knots, etc.*? Unless the Santa Ana is a very rigorous one there will be sections along the coast between these *below canyon areas* where eddy currents will develop, or where a medium onshore flow of air will actually continue in spite of the Santa Ana. Try to visualize a strong jet of air and how it affects the drift of air on either side, such as shown below.



Let's examine briefly the weather pattern that leads up to the Santa Ana situation in Southern California.

The onset of strong winds moving into Southern California from the north or northeast quarter becomes imminent when surface pressure builds up quite high over Nevada and Utah, and there are strong north winds at upper levels over Northern and Central California. Barometric pressure substantially higher over the Great Basin Region (Utah and Nevada) than over Southern California will provide the force needed to push air into Southern California from the northeast.

Before this air can reach the Southern California coast it must cross the Coast Range that stretches from Santa Barbara County to Los Angeles, San Bernardino and Riv-

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THE SANTA ANA WIND

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erside Counties. If the air moving into Southern California is initially very cold, it will find some difficulty in rising up over the Coast Range, and much of it will race through the passes and canyons creating the familiar canyon jets that blast the exposed areas below. But even over the higher ridges this cold current of air will rise then plunge down the coastal slopes to the coastal plain and shoreline.

Even though the air warms 5.5° F. per 1000 feet of descent down the coastal slopes, if it was cold enough to begin with, it can still make a clean sweep to the coast and on out over the coastal waters. The operating word here is "cold," and we speak of these as *Cold Type Santa Anas.* The air is characterized by its extreme dryness, relative humidities often 5% to 10%.

By contrast we could consider the *Warm Type Santa Ana*, where the air moving into Southern California from the Great Basin High is not much, or perhaps no colder than the air already over the coastal sections of Southern California. The air can rise over the Coast Range, and can also sweep through the coastal passes and canyons. But since in its downslope plunge it is warming 5.5° per 1000 feet of descent it will arrive at the coastal plain warmer than the air already present. This would make it unable to scoop down to displace the coastal air but would rather tend to ride on out over it. This "warm" type of Santa Ana then would be quite localized to canyons and areas just below them, and areas not near the canyons might be affected very little if at all.

The resistance of the coastal air layer against being displaced by the Warm Type Santa Ana current, that is, the persistence of the Marine Layer, even though fairly shallow, distinguishes it from the "Cold Type" which can drive the Marine Layer far out to sea.

In most cases, the first 12 hours following the arrival of the Santa Ana Wind are the most dangerous. And since they are associated with essentially fair weather, they may sneak up on you unsuspected. Frequently the high level northerly winds as they cross the San Gabriel and Tehachapi ranges will set up "wave clouds." These are the thin, sharp-edged clouds that we call "lenticular," or lens-shaped. Their presence or persistence over, or just south of, a mountain chain are a dead give-away for the strong northerly jet aloft, which is one of the ingredients of the Santa Ana. Be alert if you see these wave clouds.

The handling of Wind Warnings during Santa Ana conditions presents certain problems. If you observe the flag up, the sky clear, the humidity seemingly very low and the water glassy at your marina or launching pad, consider that a Santa Ana condition may be in effect, or on the way. Keep in mind the areas usually most affected by Santa Anas. Look for the amount of lenticular clouds. They tend to form row after row. Often there is a relationship between amount of lenticular cloud, number of rows, thickness, etc., and the strength of the Santa Ana.

By now we have at least accomplished our intent, which was to identify the weather situation with the phrasing of the forecast.

The Great Basin High pressure area that initiates the Santa Ana frequently persists from four to six days during the "preferred season," November through January; but the effects on winds over the coastal waters are usually minor during the latter half of its life cycle. As the Great Basin High shifts eastward and reduces the pressure difference between it and the Southern California coast, an onshore breeze strengthens and the marine layer moves in over the coast increasing chances of coastal fog and low clouds. Frequently a visible clue that the "High" is moving away can be found by noting the direction of motion of high clouds or aircraft vapor trails. If these seem to be moving from the north or northeast, the Great Basin High will likely continue a little longer. But when these high clouds begin to move from the west-northwest or west, the Basin High will weaken and move away rapidly, ending the Santa Ana.

Although conditions similar to Santa Anas can occur at any time of year, the "Santa Ana Season," if we can sponsor such a term, runs from late fall through the winter. This is when the Great Basin Highs are strongest and associated with air cold enough to sweep down to the Southern California Coast and out over the coastal waters.

When you discover the Coastal Wind Warning Flag up because of a Santa Ana condition, regard it as a friendly tip to be on the alert wherever you plan to do your boating, and think twice if it involves the areas usually affected by these Northeasters.

Typical problems involved with Santa Ana Winds:

Cold Type

Northeast winds 15 to 35 knots (occasionally more) especially strong in areas exposed to coastal canyons. Heavy waves and surf over island coves and anchorages open to the North through East. Final breakdown followed by formation of pockets of coastal fog over the water as the marine layer builds back in over the coast.

Warm Type

Localized gusty 15 to 30-knot northeast winds in areas exposed to coastal canyons but most other areas variable winds 5 to 10 knots. Subject to numerous pockets of coastal fog in those areas not exposed to canyon winds.